REMARKS

Reconsideration and allowance of the subject application in view of the foregoing amendments and the following remarks is respectfully requested.

Claims 1-27, 32-36, and 39 remain pending. Claims 6, 19, 28-31 and 37-38 have been cancelled. Claims 1 and 15 have been amended to specify the at least two connectors adapted to provide power to at least two fluorescent lamps. Claims 2-27 have been amended to overcome the 35 U.S.C. 112, second paragraph rejection.

The objection to claim 28 is believed overcome in view of the above cancellation of claim 28.

The objection to claims 30, 31, 37, and 38 under 37 C.F.R. 1.75(c) is believed overcome in view of the above cancellation of claims 30, 31, 37, and 38.

The rejection of claims 1-6, 8-19, 21-33, and 35-39 under 35 USC 102 (e) as being anticipated by Lys et al (U.S. patent 6,528,954) is believed overcome with respect to claims 1-6, 8-19, and 21-27 in view of the above amendments to claims 1 and 15. The remainder of the rejection with respect to claims 32, 33, 35, 36, and 39 is hereby traversed.

With respect to claim 32, the Examiner appears to be erroneously asserting that LEDs 644 of the Lys reference include filaments. A filament is defined as a metallic wire or ribbon which is heated in an incandescent lamp to produce light, by passing an electric current through the filament. McGraw-Hill Dictionary of Scientific and Technical Terms, 1974. Attached hereto is a copy of pages 60-62 of the McGraw-Hill Encyclopedia of Science & Technology, 7th Edition, 1992 describing light emitting diodes (LEDs). As can be seen from the description, contrary to the Examiner's assertion LEDs do not have filaments.

For at least the above reason, claim 32 is patentable over the Lys reference and the rejection should be withdrawn. Claims 33, 35, 36, and 39, depend, either directly or indirectly, from claim 32, include further important limitations and are patentable over the Lys reference for at least the reasons advanced above with respect to claim 32.

Claims 33, and 35-39 depend from claim 32, include further important limitations, and are patentable over the applied reference for at least the reasons advanced above with respect to claim 32. The rejection of claims 33, and 35-39 should be withdrawn.

The rejection of claims 7, 20, and 34 under 35 U.S.C. 103 (a) as being unpatentable over Lys is hereby traversed.

The Examiner asserts that it would have been obvious to one of ordinary skill in the art to use any number of sockets, such as 256, in the applied reference in order to render the desired

illumination or desired illuminated coverage. Further, the Examiner asserts that the claimed invention would require mere duplication of essential working parts involving only routine skill in the art. The Examiner is incorrect.

Despite repeated requests to identify a motivation or suggestion in the reference teaching or suggesting the asserted modification, the Examiner has failed to do so. The Examiner is improperly applying hindsight reasoning based on the present invention to make the asserted modification of the applied reference.

As described in the current specification at pages 13 and 14, "current investigations have concluded that the human eye cannot discern an increase or decrease of less than 1/256th of light output level." Advantageously, the light output from the fixture varies from off to full bright in a smooth and even gradation. This is not mere duplication of essential working parts as asserted by the Examiner.

The Examiner has failed to identify any motivation or suggestion in the reference teaching, suggesting, or describing the asserted modification. The Examiner has improperly applied hindsight reasoning based on the present invention to make the asserted modification. The Examiner has failed to identify why the modification would be obvious to a person of ordinary skill in the art or why a person of ordinary skill would be motivated to make the modification.

A statement that modifications of the prior art to meet the claimed invention would have been well within the ordinary skill of the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references. See MPEP 2143.01 quoting Ex parte Levengood, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993). The Office Action merely stated that the reference can be modified, which Appellant contends to the contrary, and does not state any desirability for making the modification. In other words, the Office Action failed to supply any objective reasons to modify the applied reference.

In accordance with MPEP §2143.01 and Al-Site Corp. v. VSI Int'l Inc., 174 F.3d 1308, 50 USPQ2d 1161 (Fed. Cir. 1999), the Examiner is requested to identify a teaching, suggestion, or motivation in either reference providing a motivation or suggestion to one of ordinary skill in the art to make the argued modification. The Examiner has not identified any teaching in Lys motivating or suggesting the asserted modification to a person of ordinary skill in the art because there is no teaching to be found. For at least this reason, the rejection of claims 7, 20, and 34 should be withdrawn.

All objections and rejections having been addressed, it is respectfully submitted that the present application should be in condition for allowance and a Notice to that effect is earnestly solicited.

To the extent necessary, please charge any shortage in fee due in connection with this filing to Deposit Account No. 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,

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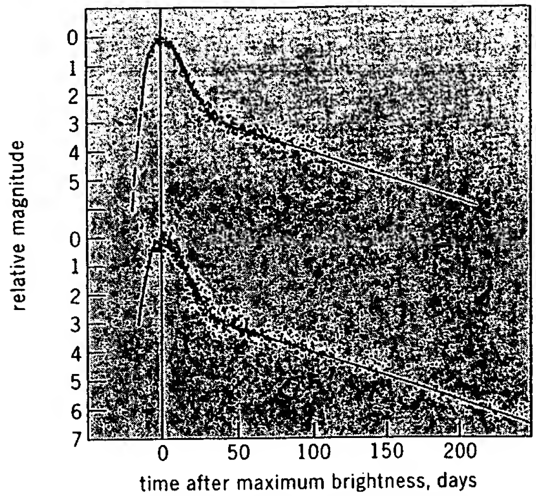

Fig. 3. Light curves for supernovae. The upper curve is a composite of blue photoelectric measurements for 22 supernovae, while the lower curve is a composite of 16 objects measured in the blue photographic magnitude system. (*After N. Bartel, ed., Workshop on Supernovae as Distance Indicators, Lectures Notes in Physics Series, Springer-Verlag, 1985*)

thermonuclear runaway. *See* Astrophysics, high-energy; Black hole; Neutron star; Nova; Supernova; X-ray astronomy; X-ray star.

Exotic objects. Variable radiation can be emitted by clouds of very high-energy electrons moving in powerful magnetic fields. Beams and jets of radiated energy may result. Pulsars are an example, rapidly rotating neutron stars that sweep the Earth with such beams up to hundreds of times per second. Their light curves are commonly observed at radio frequencies, but young pulsars also show pulses in optical light. Blazars are actively varying powerful nuclei of galaxies. They may have giant beams and jets produced by supermassive black holes, and present strongly variable light curves in radio, optical, ultraviolet, and x-rays. Quasars are modeled as having both accretion disks and jets from supermassive black holes. Their light curves show more modest variability than those of blazars. The time delays between variations in the continuous radiation from the central engine and the spectral lines emitted by the surrounding clouds of gas are interpreted to yield the physical size of these active galactic cores. *See* Galaxy, external; Pulsar; Quasar.

Richard F. Green

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Light-emitting diode

A rectifying semiconductor device which converts electric energy into electromagnetic radiation. The wavelength of the emitted radiation ranges from the green to the near infrared, that is, from about 550 to over 1300 nanometers. Blue light-emitting diodes (LEDs) have also been reported, but they are not available commercially.

Fabrication methods. Most commercial light-emitting diodes, both visible and infrared, are fabricated from group III–V compounds. These compounds contain elements such as gallium, indium, and aluminum of group III and arsenic and phosphorus of group V of the periodic table. With the addition of the proper impurities, III–V compounds can be made *p*- or *n*-type, to form *p-n* junctions. They also possess the proper band gap to produce radiation of the required wavelength and are efficient in the conversion of electric energy into radiation. The fabrication of light-emitting diodes begins with the preparation of single-crystal substrates usually made of gallium arsenide (GaAs), 250–350 micrometers (0.010–0.014 in.) thick. Both *p*- and *n*-type layers are formed over this substrate by depositing layers of semiconductor material from a vapor or from a melt.

The most commonly used light-emitting diode is the red light-emitting diode, made of gallium arsenide-phosphide on gallium arsenide substrates (**Fig. 1***a*). An *n*-type layer is grown over the substrate by vapor-phase deposition followed by a diffusion step to form the *p-n* junction. Ohmic contacts are made by evaporating metallic layers to both *n*- and *p*-type materials. The arrows indicate the emitted light at the *p-n* junction. The light generated at any point is uniformly distributed in all directions. Only a small fraction of the light striking the top surface of the diode can escape, however, due to the large difference in the refractive indices between semiconductor and air. Most of the light is internally reflected and absorbed by the substrate. Hence a typical red-light-emitting diode has only a few percent external quantum efficiency, that is, only a few percent of the electric energy results in useful light. More efficient and therefore brighter light-emitting diodes can be fabricated on a gallium phosphide substrate, which is transparent to the emitted radiation and permits the light to escape upon reflection from the back contact. Although more expensive than light-emitting diodes made of gallium arsenide, these high-efficiency light sources compete favorably in brightness with miniature incandescent lamps.

Extracting the infrared radiation into an optical fiber is even more challenging since the fiber has a narrow (10–15°) acceptance angle. It is also necessary to shorten the response time of the light-emitting diode for high data-rate transmission. This is accomplished by introducing several changes into the light-emitting diode design (Fig. 1*b*). First, the light-emitting diode structure is turned around compared with that of the red diode (Fig. 1*a*), and the radiation is extracted through an etched well on the side of the substrate. A dielectric layer separates most of the ohmic contact on the other side, limiting the active area of the junction to the size of the optical fiber. Finally, one or several additional layers are deposited (4 in Fig. 1*b*) to increase quantum efficiency and response time. The optical power from the light-emitting diode is limited by the heat dissipation of the semiconductor chip, which is usually mounted on a gold heat sink. Although some light-emitting diodes of this type are commercially available, development is being directed toward longer-wavelength devices (peak emission at 1.3 μm compared with 0.85 μm for the above light-emitting diodes) using layers containing four elements, gallium, indium, arsenic, and phosphorus, grown on indium phosphide substrates. These light-emitting diodes can send higher data rates over longer distances in the optical fibers.

Applications. Visible light-emitting diodes are used as solid-state indicator lights and as light sources for numeric and alphanumeric displays. Infrared light-emitting diodes are used in optoisolators and in optical fiber transmission in order to obtain the highest possible efficiency.

Indicators and displays. The advantages of light-emitting diodes as light sources are their small size, ruggedness, low operating temperature, long life, and compatibility with silicon integrated circuits. They are widely used as status indicators in instruments, cameras, appliances, dashboards, computer terminals, and so forth, and as nighttime illuminators for instrument panels and telephone dials. Visible light-emitting diodes are commercially available in red, orange, yellow, and green. Blue-light emitters have been made in the laboratory on wide band-gap materials such as silicon carbide, gallium nitride, and zinc sulfide. These devices have different structures than the *p-n* junctions described above, their fabrication is more expensive, and their brightness is lower by approximately two orders of magnitude than that of other light-emitting diodes, and hence they are not employed commercially.

Some of the most commonly used light-emitting diode structures are shown in **Fig. 2**. The metal-flanged, single-lead design (Fig. 2*a*) is very rugged and easy to insert; the lead-frame package (Fig. 2*b*) can easily incorporate built-in voltage regulators so that the light-emitting diodes can be operated over a range of input voltages such as 3–15 V. Some packages have provisions to focus or redistribute the light, such as the lead frame with a built-in reflector (Fig. 2*c*). Light-emitting diodes can also be employed to light up a segment of a large numeric display, used for example on alarm clocks; or a small numeric display with seven light-emitting diodes can be formed on a single substrate, as commonly used on watches and hand-held calculators.

Optoisolators. Infrared light-emitting diodes with solid-state photodetectors provide an optical interface in electric circuits. In the simplest optical interface, the optoisolator, a light-emitting diode and a photodetector are optically coupled, but electrically isolated, in a small package. This device can be used, for example, at the interface between two different circuits, such as the switching equipment in a telephone central office and the connecting loop circuit which carries the signals to the telephone sets. The electric signal from the central office is converted to radiation by the light-emitting diode, which in turn is converted back into an electric signal by the photodetector before it enters the loop circuit. This type of interface is traditionally provided by electromechanical relays or isolation transformers. The electrical isolation resulting from the optical path protects the central office from electromagnetic interferences such as lightning which hits telephone wires or surge currents from electromechanical relays. Light-emitting diodes are ideal for this application because they are small, rugged, efficient, reliable, and can be modulated to carry high-frequency signals.

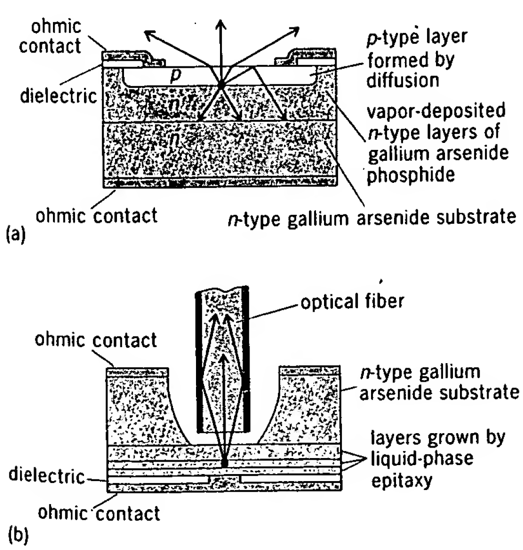

Fig. 1. Diagrams of light-emitting diodes. (*a*) Red-light-emitting gallium arsenide-phosphide LED. (*b*) Infrared, etched-well LED designed for coupling radiation into an optical fiber.

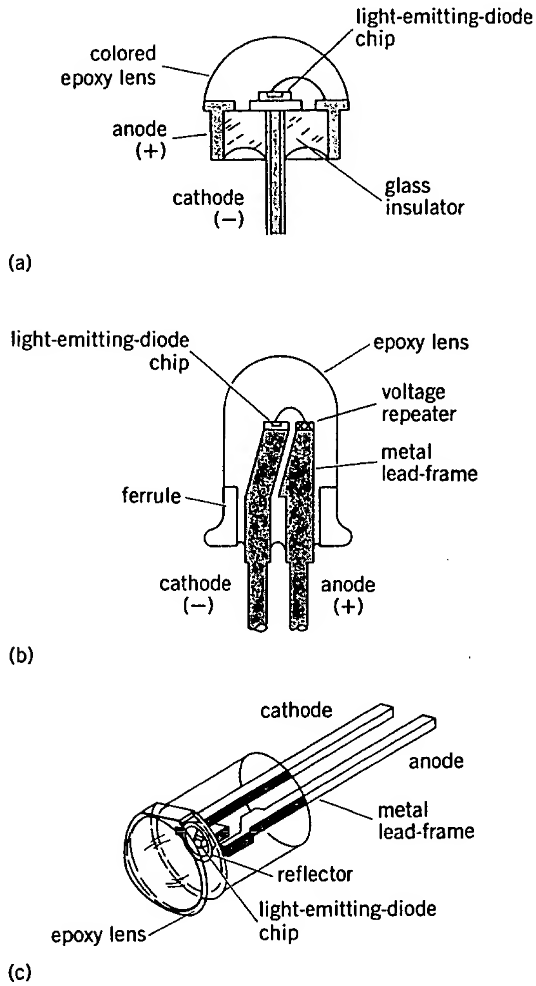

Fig. 2. Light-emitting diode lamps. (*a*) Metal-flanged single-lead header. (*b*) Lead-frame package with built-in resistor. (*c*) Lead-frame package with built-in reflector.

In a typical optoisolator structure (**Fig. 3**), the light-emitting diode and the phototransistor are mounted on separate metal lead frames, and the two components are coupled optically through a transparent plastic encapsulant. This plastic is also the source of electrical isolation, typically on the order of 2500 V. Final encapsulation is completed with a black, opaque overmold which also provides mechanical stability. Optoisolators are compatible with silicon integrated circuits in size, reliability, and performance parameters, giving them a prominent role in modern solid-state circuits. SEE OPTICAL ISOLATOR.

Optical fiber transmission. Another rapidly evolving

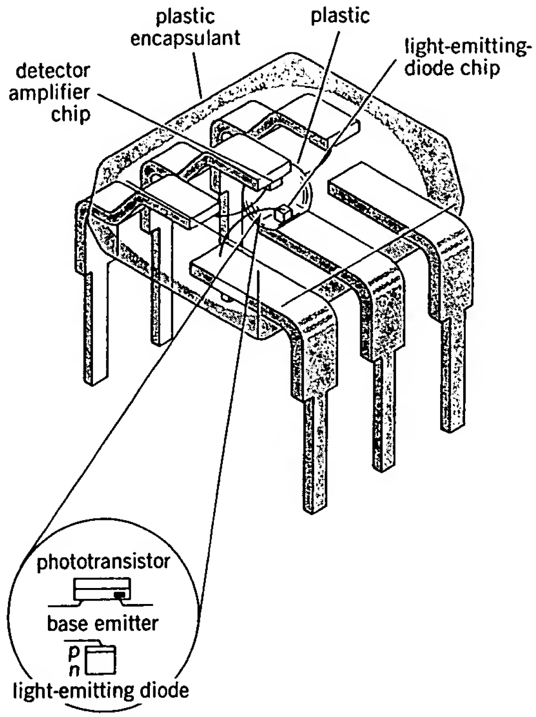

Fig. 3. Typical optoisolator in plastic-encapsulated dual in-line package.

application of infrared light-emitting diodes is in optical fiber transmission. The optical signal is fed into a thin (50–100 μm or 0.002–0.004 in. in diameter) optical fiber and transmitted over distances ranging from several hundred meters to over 10 km (6 mi). At the other end of the fiber, a photodetector converts the optical signals back to electric signals similar to those in optoisolators. This fiber, which replaces coaxial cables, is smaller in volume, less expensive, and immune to electromagnetic interference. It also transmits higher data rates and provides longer repeater spacings than metal conductors. Since doped silica fibers exhibit both low loss and minimum material dispersion near 1.3 μm, light-emitting diode sources at this wavelength can achieve a repeater spacing of 10 km (6 mi) at a data rate of 250 megabits per second. This will provide a major market for high-performance light-emitting diodes and support the development of long-wave-length light-emitting diodes. *See* Optical communications; Optical fibers.

For further discussion of the properties of *p-n* junctions and light generation in solid-state devices *see* Electroluminescence; Junction diode; Junction transistor; Laser.

A. A. Bergh

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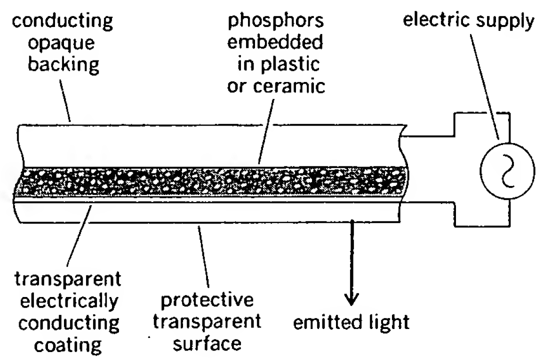
Light panel

A surface-area light source that employs the principle of electroluminescence to produce light. Light panels are composed of two sheets of electrically conductive material, one a thin conducting backing and the other a transparent conductive film, placed on opposite sides of a plastic or ceramic sheet impregnated with a phosphor, such as zinc sulfide; and small amounts of compounds of copper or manganese. When an alternating voltage is applied to the conductive sheets, an electric field is applied to the phosphor. Each time the electric field changes, it dislodges electrons from the edges of the phosphor crystals. As these electrons fall back to their normal atomic state, they affect the atoms of the slight "impurities" of copper or manganese, and radiation of the wavelength of light is emitted. *See* Electroluminescence.

In contrast to incandescent, vapor-discharge, and fluorescent lamps, which are essentially point or line sources of light, the electroluminescent light panel is essentially a surface source of light. Complete freedom of size and shape is a fascinating aspect of luminescent cells (see **illus.**).

Brightness of the panel depends upon the voltage applied to the phosphor layer and upon the electrical frequency. In general, higher voltage and higher frequency both result in a brighter panel. Blue, green, red, or yellow light can be produced by the choice of phosphors, and the proper blend of these colors produces white light. Color can be varied for a particular



Simplified diagram of an electroluminescent cell; the sketch is not drawn to scale.

phosphor by changing the frequency of the applied voltage. Increasing the frequency shifts the color toward the blue end of the spectrum.

The efficiency of these light panels is only a fraction of that of the most efficient fluorescent lamps. Theoretical limits indicate, however, that the efficiency can be further improved, probably to exceed that for fluorescent lamps. Because panel lights employ no filaments and no evacuated or gas-filled bulbs, replacement of units is virtually eliminated. Glareless uniform distribution of light from large-area sources is possible without shades, louvers, or other control devices. *See* Fluorescent lamp; Illumination.

Warren B. Boast

Light projector

A device designed to produce controlled beams of light that can be projected over considerable distances. The function of a light projector may be to light a limited area, such as the face of a building or an actor on a stage, or to produce apparent brightness at the light source that makes the source itself visible